PATENT SPECIFICATION 951,186

DRAWINGS ATTACHED.

951,186

Date of Application and filing Complete Specification: *Dec. 18, 1962.* *No. 47654/62.*

(Patent of Addition to No. 932,948, dated Jan. 8, 1962).

Complete Specification Published: March 4, 1964.

Index at Acceptance:—**B7** G41A; **B7** W(5, 31B); **F2** R.

International Classification:—**B 64 d** (B 64 c, F 06 c).

COMPLETE SPECIFICATION.

Vertical Take-Off and Landing Aircraft.

I, TEMPLE LESLIE, Flat B, 9 Botanic Crescent, Glasgow, N.W., a British Subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an aircraft capable of taking off and landing vertically and is an improvement in the invention described and claimed in Complete Specification No. 608/62 (Serial No. 932,948). In the invention disclosed in Specification No. 932,948 the means for lift comprise:—

1. An assembly consisting of a vertically mounted turbojet engine whose air intake is uppermost and whose jet pipe is constructed as an annulus and is flared outward to form an annular nozzle through which the jet efflux is ducted horizontally and radially, and an annular aerofoil or a cascade of annular aerofoils surrounding the annular nozzle, this assembly being housed in a convergent nozzle shaped well or throat in the aircraft's fuselage;
2. An assembly consisting of an annular conical diffuser surrounding the annular aerofoil or cascade of annular aerofoils, a pressure chamber and a vertically disposed annular divergent nozzle directed to atmosphere;
3. An assembly consisting of ducts leading from the pressure chamber and control fins located in the duct orifices in the aircraft's sides.

In the invention now disclosed the means for lift comprise the foregoing means 1, 2 and 3 and in addition:—

4. A means for boundary layer flow control adapted so that boundary layer air sucked through the aircraft's skin is accelerated through the vertically disposed annular divergent nozzle referred to in 2 above;
5. Stub wings which house an extended duct system leading from the pressure chamber referred to in 2 above to control fins located in the duct orifices at the tips of the stub wings.

The means for boundary layer flow control in the present invention are already known to the extent that slits, or perforations, or strips of porous material in the aircraft's skin, cells below the skin, throttle holes and ducts are employed. The means for applying suction in the present invention is an annular passage following the contour of the well in the aircraft's fuselage and connecting an air collecting chamber with the low pressure region existing at the throat of the well when the turbojet engine which the well houses is operating. Besides reducing drag, boundary layer flow control in the present invention is used to provide lift.

The stub wings are intended to produce additional lift in forward flight and to improve lateral stabilitly. The stub wing span is in effect variable, due to the operation of the control fins located at the wing tips, which control fins when not in the fully closed position allow jet sheets to issue outwardly from the stub wing tips.

So that the present invention may be readily understood and carried into effect the following is a description by way of example of a practical embodiment, with

[*Price* 4*s*. 6*d*.]

reference to the accompanying drawings in which:—

Figure 1 is a side elevation in section of the aircraft.

Figure 2 is a plan view of the aircraft, partly external and partly with portions of the structure removed to reveal internal parts.

Figure 3 is a transverse section of the aircraft at the line AB in Figure 1.

Figure 4 is a rear elevation of the aircraft.

Figure 5 is a transverse section of the fuselage at the line CD in Figure 2, showing a boundary layer flow control duct.

Figure 6 is a transverse section of the fuselage at the line KL in Figure 2, showing boundary layer flow control cells.

Figure 7 is a chordwise section of the stub wing at the line EF in Figure 2.

Figure 8 is a section on a larger scale of a boundary layer flow control cell and duct.

Figure 9 is a section at the line MN in Figure 8.

Figure 10 is a section on a larger scale at the line GH in Figure 2 of the stub wing tip and control fin, showing the control fin in the fully closed position and a dotted outline of the control fin in the fully open position.

Figure 11 is a plan view of a portion of the stub wing tip and control fin, showing the angled fit between the end of the control fin and the side of the control fin duct orifice.

Figure 12 is a plan view of a portion of the stub wing tip and control fin, showing a control fin slot.

Referring to the drawings, three torbojet engines 1 are mounted vertically with air intakes uppermost in three corresponding convergent nozzle shaped wells 2, which are fitted for purposes of guiding the air inflow with flared vanes 3, in the aircraft's fluselage 4. Each turbojet engine is braced to the wall of its corresponding well by four radial braces 5. The jet pipe of each turbojet engine is constructed as an annulus and is flared outward to form an annual nozzle 6 through which the jet efflux is ducted radially to a cascade of annular aerofoils 7. A cuff or sleeve 2 shrouds each annular nozzle 6 and is designed to induce streams of air to flow parallel to and totally enclose the jet efflux as it issues from the annular nozzle. Surrounding each cascade of annular aerofoils is an annular conical diffuser 9, which leads to a pressure chamber 10, which in turn leads to a vertically disposed annular divergent nozzle 11 communicating with the atmosphere.

From either side of each pressure chamber ducts 12 lead spanwise to control fins 13 at the tips of the stub wings 14.

The three wells 1 are each double walled to form, between the walls, annular passages 15 which are provided with long radially disposed vanes 16 and, at the junction with the air collecting chamber 18, with short radial vanes 17. The air collecting chamber has taping extensions 19 and 20 at either end. From the collecting chamber and its extensions, ducts 21 extend beneath the skin of the fuselage and of the stub wings. These ducts communicate by means of throttle holes 22 with cells 23 lying immediately under the aircraft's skin. Over the area of fuselage and stub wings indicated in Figure 2, parallel slits 24 are cut in the aircraft's skin for the purpose of removing a portion of the boundary layer air by suction into the cells 23, the sucked air passing thence into the ducts 21, thence into the air collecting chamber 18 and its extensions 19 and 20, and thence through the annular passages 15 to join the main induced air flow down the wells 2 at the throats of the wells.

The two turbojet engines 25 located at the rear of the aircraft are for propulsion.

The arrows in Figure 1 indicate the general direction of flow in and around the aircraft.

The operation of the present invention is similar to that of the invention revealed in Specification No. 932,948 and is briefly as follows:—

Before starting the turbojet engines 1, the control fins 13 are adjusted, by mechanical means not shown and which would be locate in the housing 26, so that they are in the fully open position indicated by the dotted outline in Figure 10, in which position there is no restriction on flow in the control fin ducts 12. On starting the turbojet engines 1, the jet efflux from the annular nozzles 6 flows radially over the cascades of annular aerofoils 7 and in so doing expands, creating a region of low pressure at the throat of each well 2. A flow of air is thus induced down the wells and meeting the jet effluxes at the throats of the wells is entrained and accelerated radially outward. The combined flow of jet efflux and entrained air passes into the annular conical diffuser 9 and is compressed, the compressed flow then passing into the pressure chamber 10. When the control fins 13 are in the fully open position there is a bleed from the pressure chamber into the control fin ducts 12, and only a portion of the flow from the annular conical diffuser is exhausted vertically to atmosphere through the annular divergent nozzles 11, this vertically exhausted portion of flow creating a primary lift which neutralises part of the all-up weight. The remainder of the flow from the annular conical diffuser is exhausted horizontally to atmosphere through the con-

trol fin duct orifices at the tips of the stub wings.

The additional lift required to make the aircraft take off vertically is provided by bringing the control fins into the path of the jets issuing from the control fin duct orifices at the stub wing tips. By doing so the amount of flow in the control fin ducts is varied. The effect is to increase the mass flow through the vertical annular divergent nozzles 11 and thus the lift from this source, and to create an aerodynamic lift due to the flow of the efflux from the control fin duct orifices over the control fins, which are aerofoils.

To augment the lift at take off, in cases where a rapid ascent is required, an after-burning means may be incorporated in the vertical annular divergent nozzles.

After take off the aircraft may be trimmed by adjusting the control fins, which are separately adjustable, so that more or less lift is obtained in the region of each control fin as may be required.

As there is a sideways thrust from the efflux from the control fin duct orifices, adjustment of the control fins not only affects trim but may be made to affect the directional attitude of the aircraft.

Longitudinal movement of the aircraft may also be effected by adjustment of the control fins. Thus, if the aircraft be trimmed so as to have a forward dip, it will move forward due to the horizontal component of thrust that arises due to the tilting of the vertical annular divergent nozzles 11. Likewise, by trimming the aircraft so that it dips rearward, it will move rearward.

The main means for forward movement are the two turbojet engines 25, which may be started after the initial trimming of the aircraft. As the aircraft moves forward the centre of lift changes, largely due to the aerodynamic lift from the stub wings, and this change may be counterbalanced by further adjustment of the control fins.

In cruising flight the control fins may be positioned so that the jet sheets issuing from the control fin duct orifices at the stub wing tips act like extensions to the wing span an thus influence the air circulation round the stub wings. To protect and contain these jet sheets as far as possible, slots 27 in the control fins allow some of the efflux from the control fin duct orifices to issue as jet walls. At each end of each control fin there is a similar jet wall, created by the efflux issuing through the gap produced when the inclined ends of the control fins separate from the inclined sides of the control fin duct orifices as the control fins are moved outward.

Reduction of forward speed may be obtained by throttling or shutting off the turbojet engines 25, or by adjusting the aircraft's trim so that it dips rearward; or by both means together.

Loss of height is governed by loss of forward speed, and by adjustment of the control fins if necessary to the point of minimum discharge through the vertical annular divergent nozzles 11.

Suction of air through the aircraft's skin by means of the boundary layer flow control system begins as soon as one or more of the turbojet engines 1 are started. Means for throttling the total amount of air sucked through the aircraft's skin may be incorporated in the boundary layer flow control system, and also means for preventing a reversal of flow.

WHAT I CLAIM IS:—

1. A means for vertical take-off and landing of an aircraft comprising in combination a vertically mounted turbojet engine whose air intake is uppermost and whose jet pipe is constructed as an annulus and is flared outward to form an annular nozzle directing the jet efflux radially to an annular aerofoil or a cascade of annular aerofoils surrounding the radially issuing jet efflux and co-operating with it so as to produce lift, a convergent nozzle shaped well or throat in the aircraft's fluselage to house the assembly of turbojet engine and annular aerofoil or cascade of annular aerofoils, the well having double walls which form between them a convergent annular passage leading from an air collecting chamber deriving its air supply by suction through the aircraft's skin to the throat of the nozzle shaped well, an annular conical diffuser, a pressure chamber and a vertical annular divergent nozzle.

2. A means for vertical take-off and landing of an aircraft as in Claim 1, wherein a bleed is provided from the pressure chamber and led by spanwise ducts to control fins placed in the duct orifices at the tips of stub wings in which the ducts are housed.

3. A means for vertical take-off and landing of an aircraft comprising the parts constructed, arranged and adapted for operation substantially as hereinbefore described with reference to Figues 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 of the accompanying drawings.

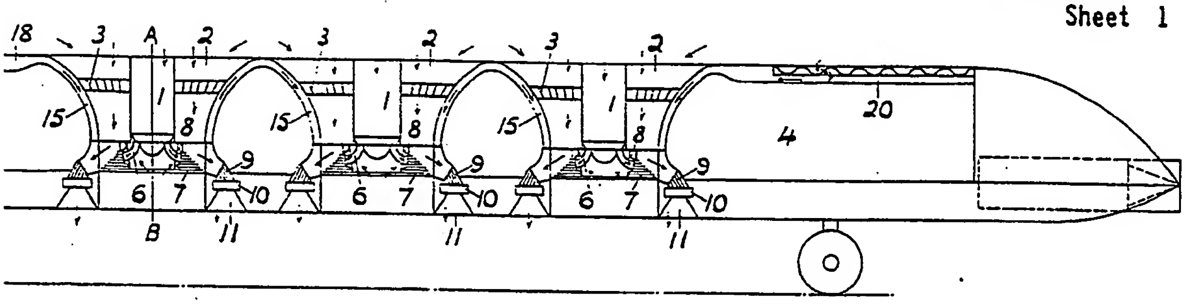
T. LESLIE.

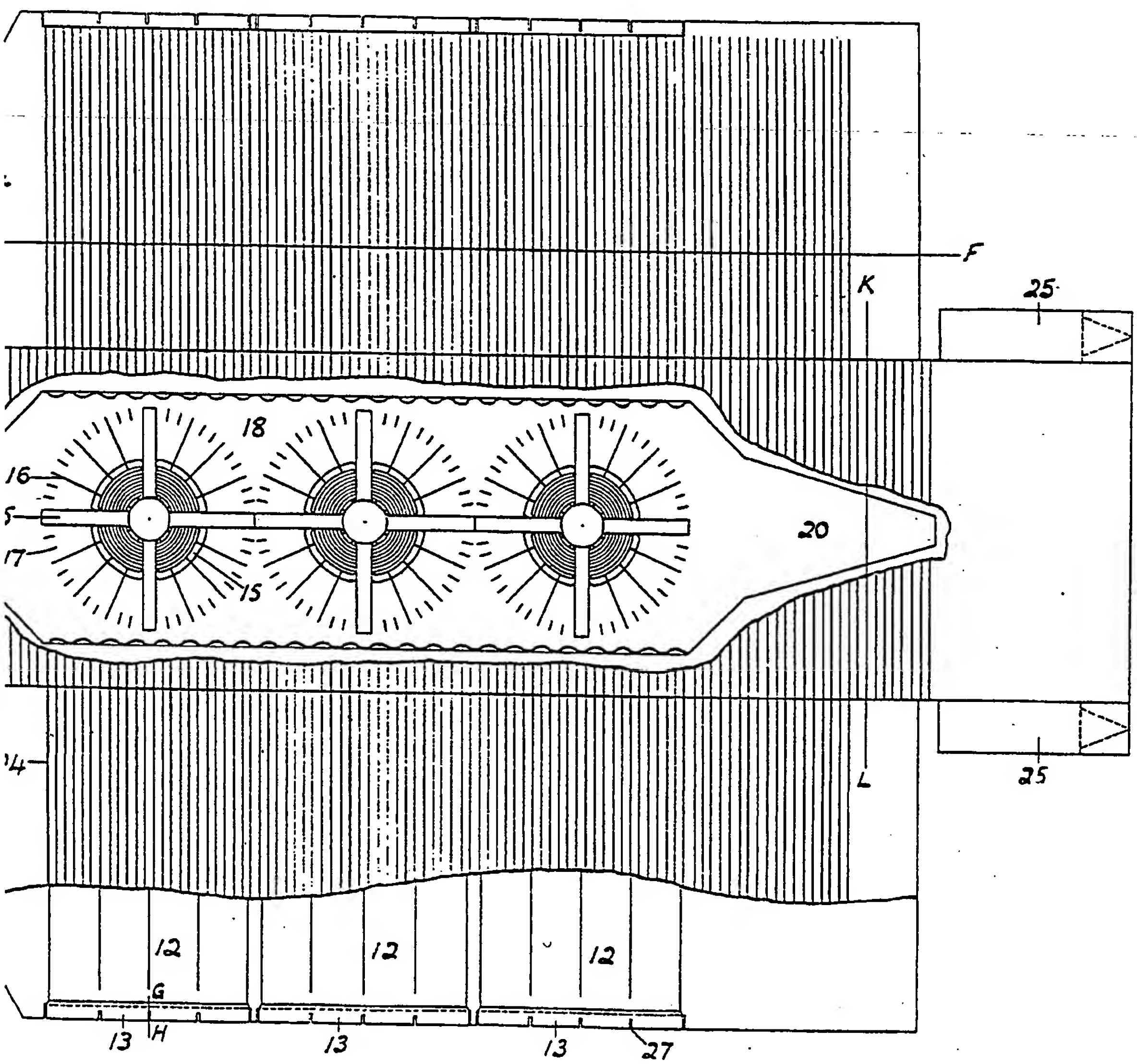
Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1964.
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2,
from which copies may be obtained.

951186 COMPLETE SPECIFICATI(

2 SHEETS *This drawing is a reproductio[n of] the Original on a reduced sc[ale]*

Sheet 1





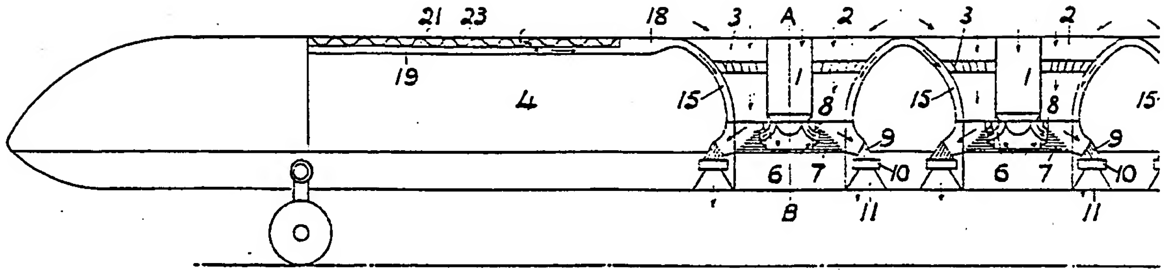


FIGURE 1

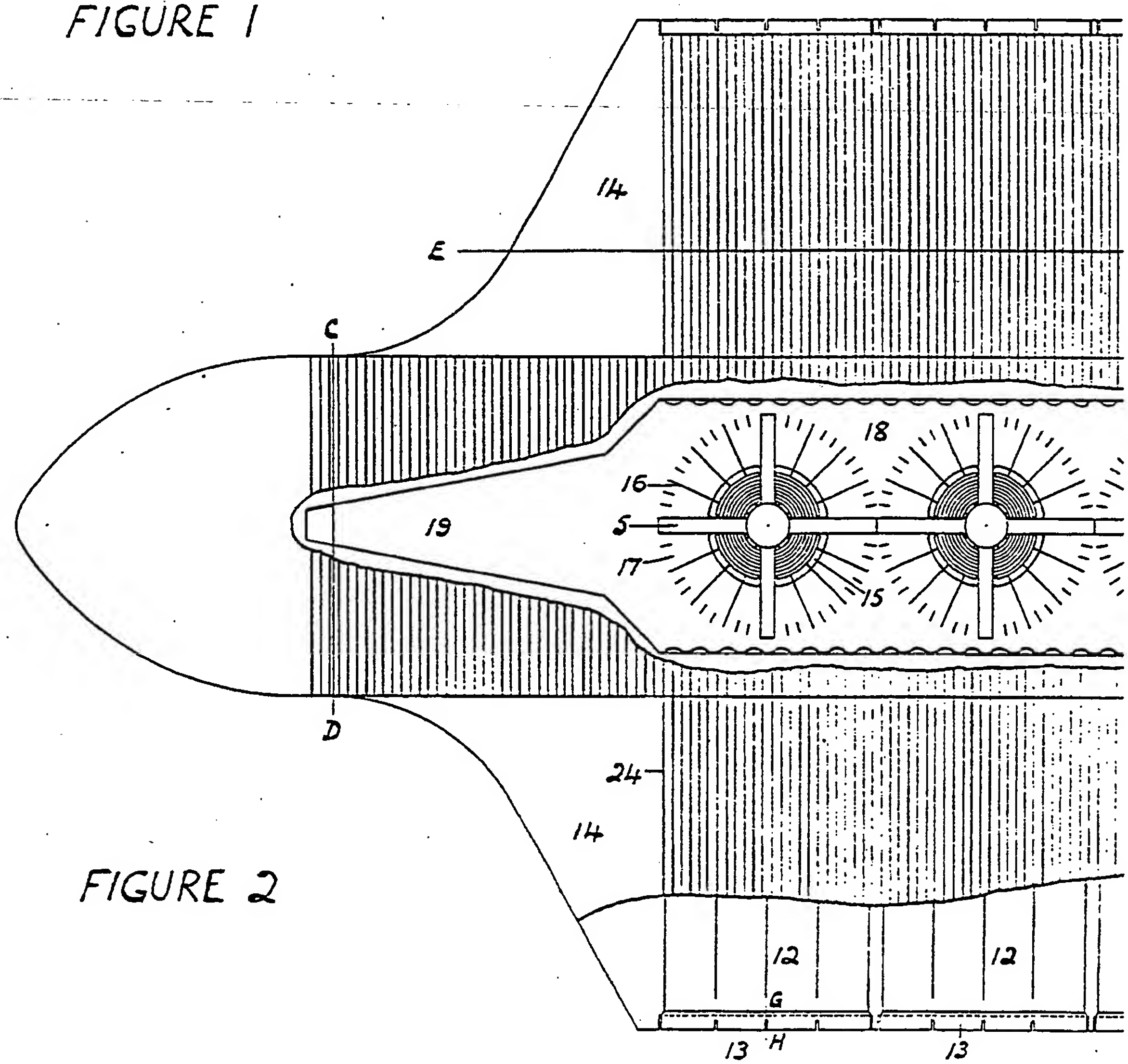


FIGURE 2

951186 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

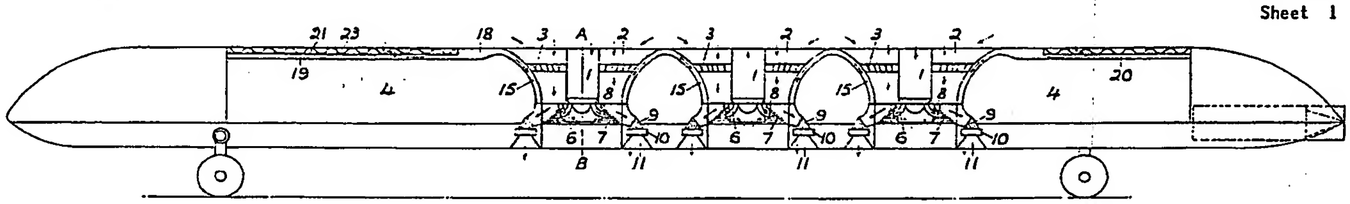


FIGURE 1

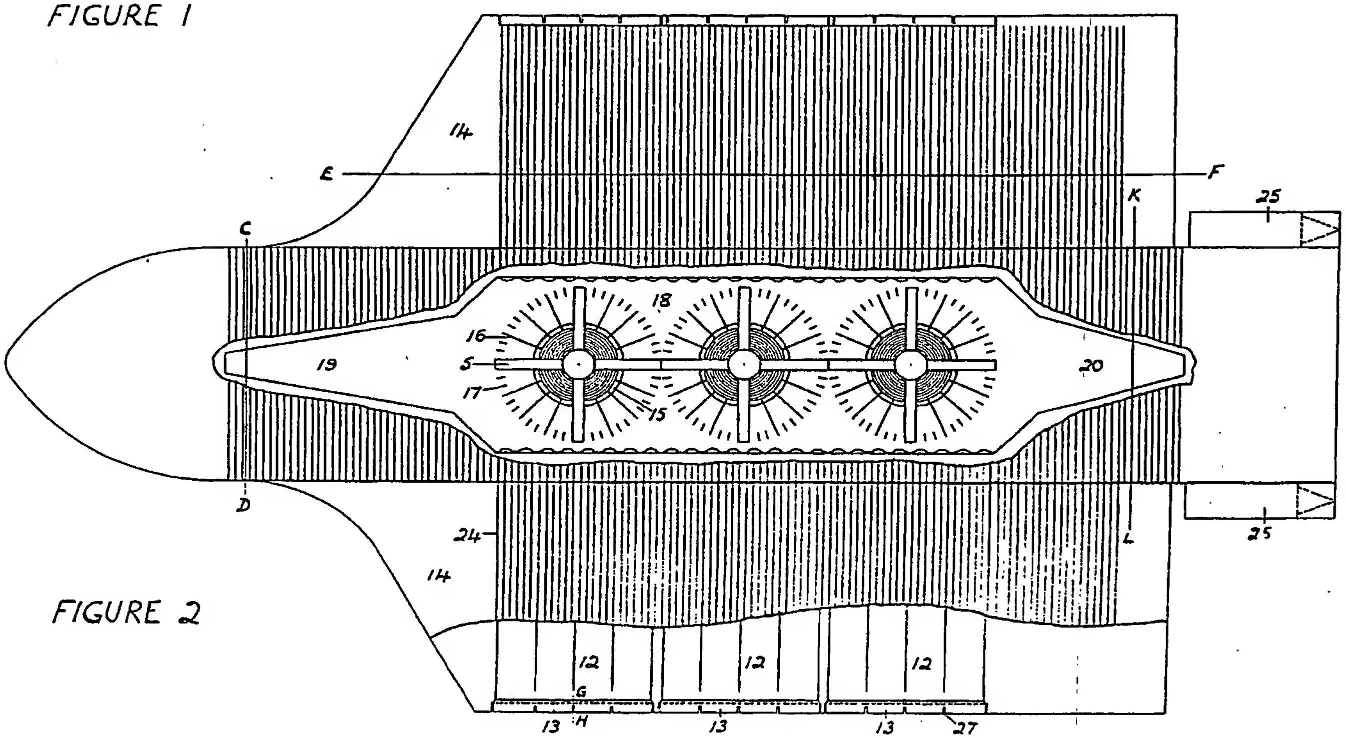
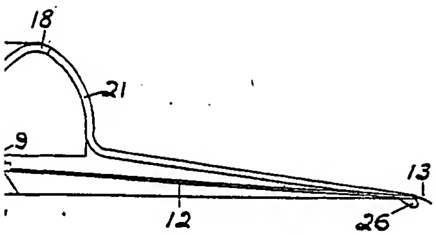


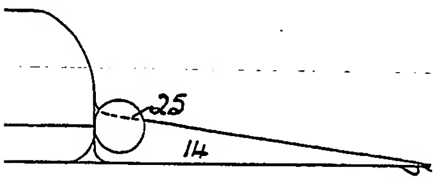
FIGURE 2

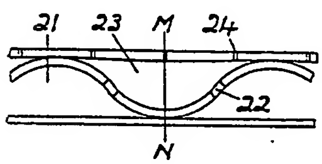
951186 COMPLETE SPECIFICATIC

2 SHEETS This drawing is a reproductior the Original on a reduced sc

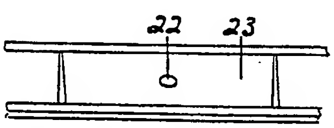
Sheet 2



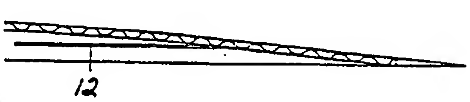




IGURE 8



IGURE 9



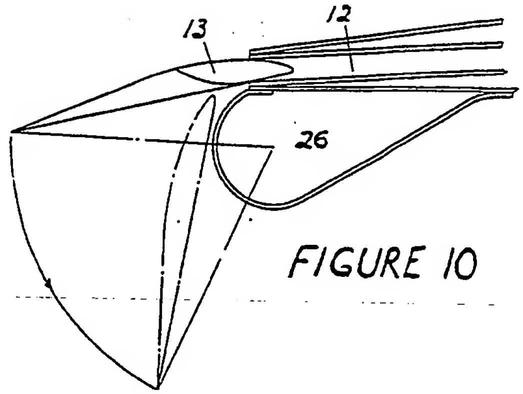


FIGURE 10

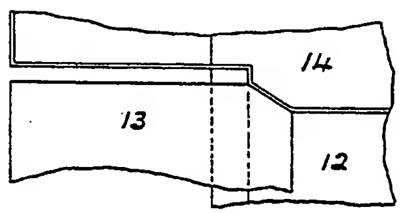


FIGURE 11

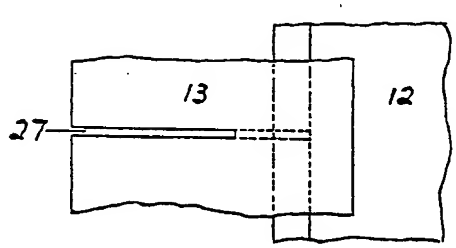


FIGURE 12

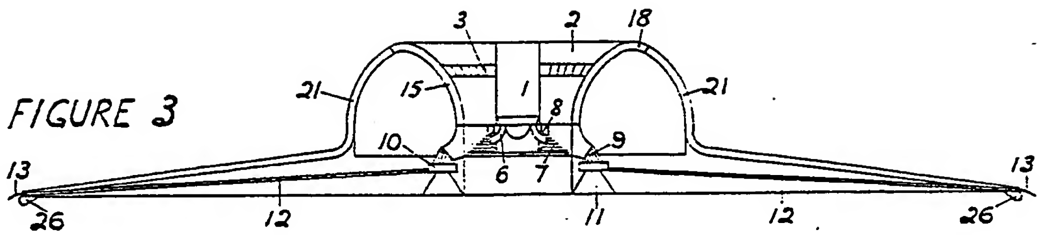


FIGURE 3

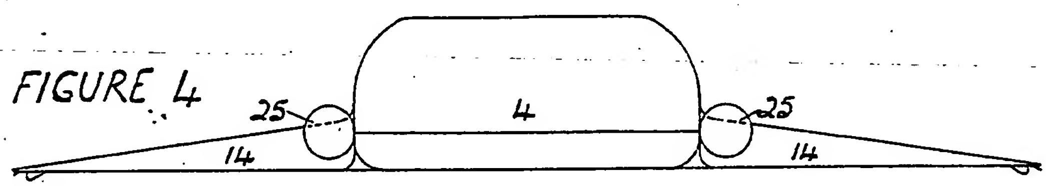


FIGURE 4

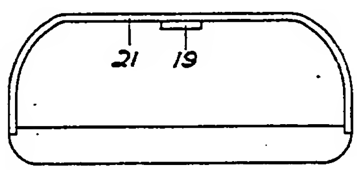


FIGURE 5

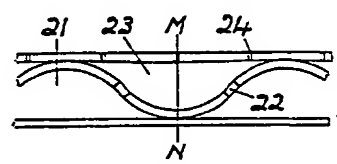


FIGURE 8

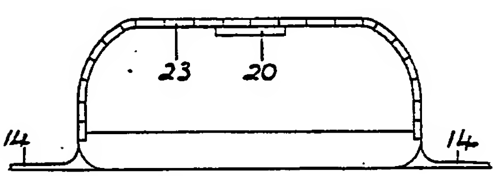


FIGURE 6

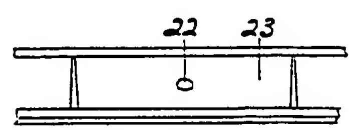


FIGURE 9

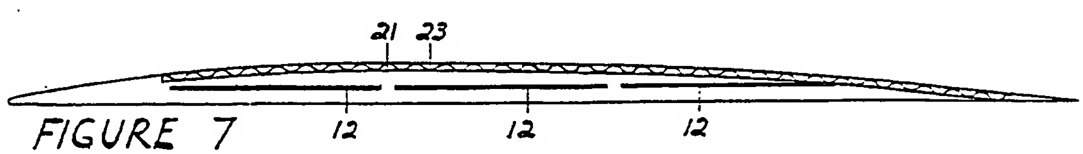


FIGURE 7

951186 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

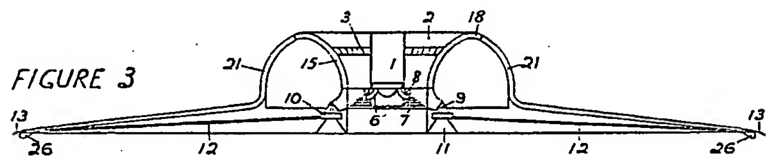


FIGURE 3

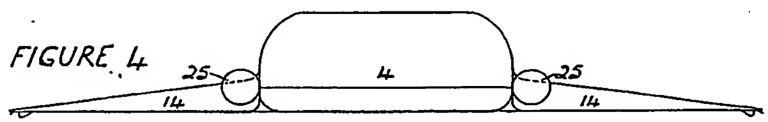


FIGURE 4

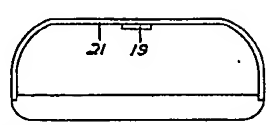


FIGURE 5

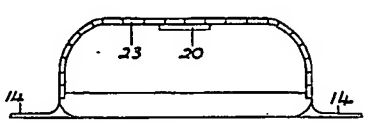


FIGURE 6

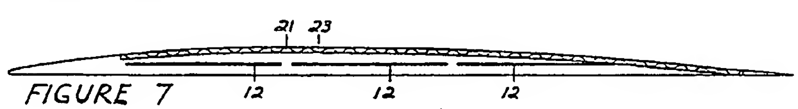


FIGURE 7

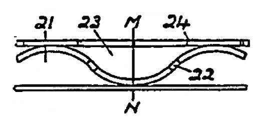


FIGURE 8

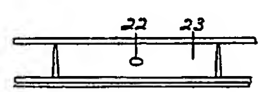


FIGURE 9

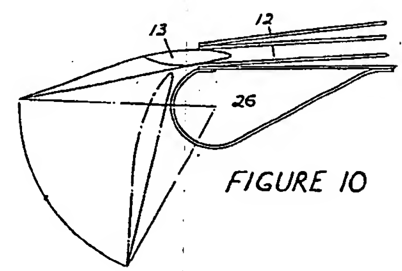


FIGURE 10

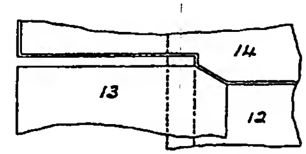


FIGURE 11

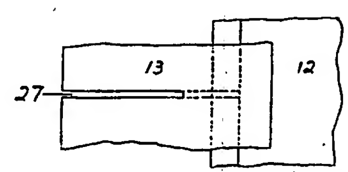


FIGURE 12